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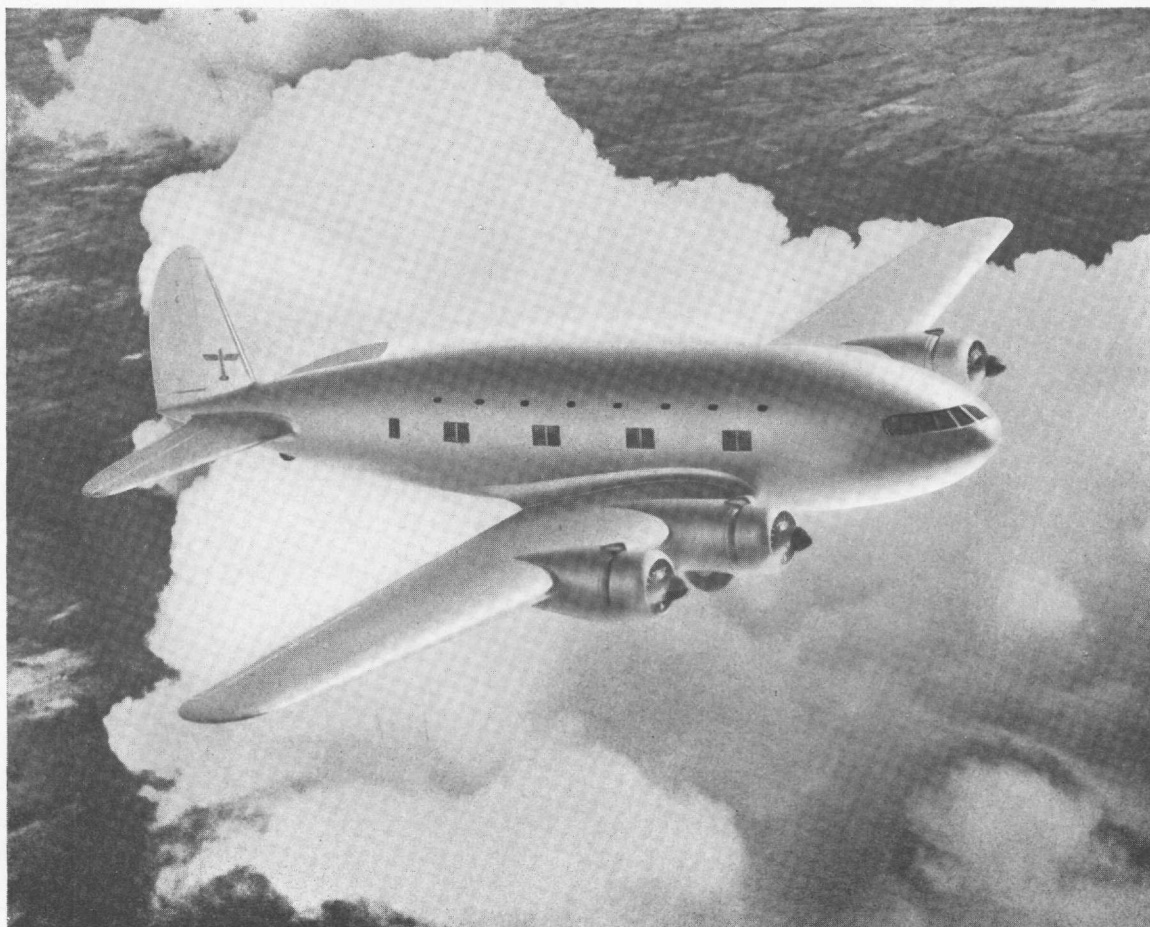
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This synthetic photograph shows how the Stratoliner will look in flight. Fleets of these four engined planes are now under construction.

A SUPER HIGHWAY IN THE SKY

By F. ROBERT SEGNA

FOR several years now, we have been hearing about Stratosphere flights and scientific explorations into the upper levels of the atmosphere by many eminent research engineers. What is it all about? What is the purpose and value of all these dangerous trips into this spacious and mystical realm of nothingness? Surely it could not be just for the adventure of exploration. There must be something up there of practical value to the commercial side of scientific and engineering circles.

In looking into the field of stratosphere flights in the last few years, try to understand the extreme difficulties that these pioneers worked under and the wonderful results that they accomplished to add to the speed, comfort, and safety of modern flying.

Activity in this field began with the lighter-than-air crafts, namely; the balloon. Rapid flights into high altitudes were provided long before the more complicated airplane could be developed to travel in this strata. Economy as well as simple and convenient handling were essential reasons for the choice of this type.

Many times in previous years, bold adventurers have ascended to altitudes which established new world records, but these attempts were purposely record breaking, and they therefore resulted in little scientific value. The chief importance of such dangerous undertakings is the actual proof to the world that such regions can actually be penetrated, and they might result in some practical usefulness.

Then again, scientists, like Dr. Piccard, who were seeking the valuable mysteries of the cosmic rays, employed this type of craft for their ascensions.

The latest record flight was completed in the later part of 1935 when two Wright Field officers, Major Albert Stevens and Captain Orvil Anderson in their gondola stratosphere balloon, "Explorer II", smashed all records for altitude in the upper stratosphere. They attained the height of 72,394.7 feet in the upper stratosphere, and brought back many discoveries regarding cosmic rays and conditions at that elevation. Naturally, they also encountered and discovered valuable laws and factors that influence a craft flying at that level and lower. From their data, approximate charts were recorded with the temperature, density of the air, and the climatic variations at various heights.

Commercial aviators are not as interested in the stratosphere as the scientists are. The region called the "troposphere", or more commonly, the sub-stratosphere, located just above the heavy air belt that brews surface weather conditions, is the territory that is most desirable to them.

The reasons for this choice are obviously very simple

if one understands the conditions that exist at this altitude and the true stratosphere. As we go upward, not only does the atmosphere pressure and density decrease, but the movement of the air in prevailing winds becomes swifter and more uniform, and the temperature decreases steadily with the altitude—normally about three and a third degrees every thousand feet. The thermometer gets down to 65 degrees below zero Fahrenheit at an altitude of approximately 35,000 feet, and from there on upward, according to research data, it ceases to get colder. This stable temperature region, extending as far up as there is still a trace of atmosphere, is the true stratosphere.

The sub-stratosphere is located between 14,000 feet (where most people begin to need extra oxygen to live), and 35,000 feet where the stratosphere begins. Here we can get most of the benefits of the stratosphere without getting into the complex problems of flight in the extremely rare atmosphere and low temperature of the true stratosphere. At 20,000 feet, we find there is very little difference between summer and winter. No matter what the weather is below, we can count on the thermometer registering relatively close to ten degrees below zero all the time. Although the winds are not entirely constant at this level, they are considerably more so than at normal flight levels, and the air is virtually free from the turbulence that sometimes gives air planes a "rough ride" on lower levels.

Storm clouds and icing conditions, except on rare occasions, lie below this flight path. When thunderheads do extend into the upper levels they are so localized that they may be readily detoured. Normal clouds at this height are so thin that they will appear as thin smoke rather than fog when an airplane passes through them.

The United States Army Air Corps, which had already established itself as a definite leader in the exploration of the stratosphere by balloon flights, took on the job of discovering the solutions to the involved problems in perfecting aeronautical progress in the stratosphere.

About 1937, in their laboratories at Wright Field in Dayton, they constructed a high-altitude laboratory that is the most complete in the world. Pressure conditions in it can be produced to the same conditions that would prevail at 80,000 ft., and the temperature can be lowered to $-65^{\circ}\text{F}.$!

It consists of three pressure chambers equipped to reproduce stratosphere conditions on the ground. The central compartment has a smaller portion built inside of it to represent the actual fuselage of an airplane trav-

cling far above the clouds. A pilot crawls in this second chamber and tests are made on him to determine how he would react in a pressure sealed fuselage under stratosphere conditions, without even getting him off the ground. He is able to communicate with the outside by telephone connection in reference to the operations.

After many extensive tests were made, and basic conclusions and principles were drawn up, the Army purchased a specially-constructed Lockheed airplane for operation in the sub-stratosphere. Called the XC-35, it was similar to the standard Lockheed Electra passenger transport that Amelia Earhart used in her trip across the Atlantic and with which Howard Hughes recently established a new round-the-world record, except for the pressure-envelope fuselage construction, and the super-charged Wasp engines. It is constructed and equipped to function properly between the altitudes of 12,000 and 25,000 feet.

The Army officials definitely stated that the ship was purchased not for high performance or to break records, but solely as an experimental laboratory to find new items of equipment and engineering practices necessary in high-altitude flying for both military and commercial airplanes of today.

The fuselage is of a semi-monocoupe construction with a circular cross-section throughout. The framework is constructed of an aluminum alloy with an extra heavy covering to withstand a pressure of 15 pounds per square inch. The portion immediately ahead of the tail and behind the main cabin compartment is not sealed, this to allow for structure flexibility in expansion and contraction where the temperature differs between -54° and 100°F .

Temperature, pressure, and heavy ice and fog formations are the greatest hazards that they must encounter. The temperature and pressure is controlled by an operator in the cabin who has charge of all the controls regulating cabin pressure, oxygen supply, and emergency valves, along with the inside temperature, humidity and pressure controls. The temperature is maintained between 50° and 70°F . at all times from the heat obtained from engine exhausts. The oxygen supply is mixed with the incoming air from the atmosphere which enters the ship at the leading edge of the wings and is compressed and heated to the normal conditions. Ventilation is provided at all altitudes.

Five windows, 5x12 inches are built on each side of the cabin to afford vision and light. Two air-sealed doors are built into the compartment, one of which is used only for emergencies. Let us now determine what the results of these extensive tests actually determined and the theories and advantages they helped formulate. Here the army has a completely sealed airplane that has produced normal lower level conditions in the sub-stratosphere where a human cannot normally exist. The ship will fly in these conditions, but what does this prove? The ship's performance in those "upper levels"

and at normal altitudes will quickly explain that.

In a test flight at 21,000 feet and under normal cruising power, the ship covered a 220-mile distance in thirty-eight minutes to average 347 m.p.h.! Just contemplate that speed, and compare it with the normal transport at 10,000 and 12,000 feet which does about 215 m.p.h.—over 50 per cent greater!

What is the reason for all this increase at the same power? The answer is in a law of aerodynamics that the engineers formulated: the resistance offered by the air is equal to the product of the density times the square of the velocity of the craft. Since density of the air is changing, the velocity varies as the cube root of the density of the air. In short, the density of the air at high altitudes is less and affords less resistance, thereby permitting greater speeds.

Now you can see the reason for his intense work on the subject. When accomplished, 50 per cent more work will be gained for the same price. That is another law of nature that has been developed into a modern miracle by the scientists.

Now that we have all these extensive data, what is the commercial field intending to do with it?

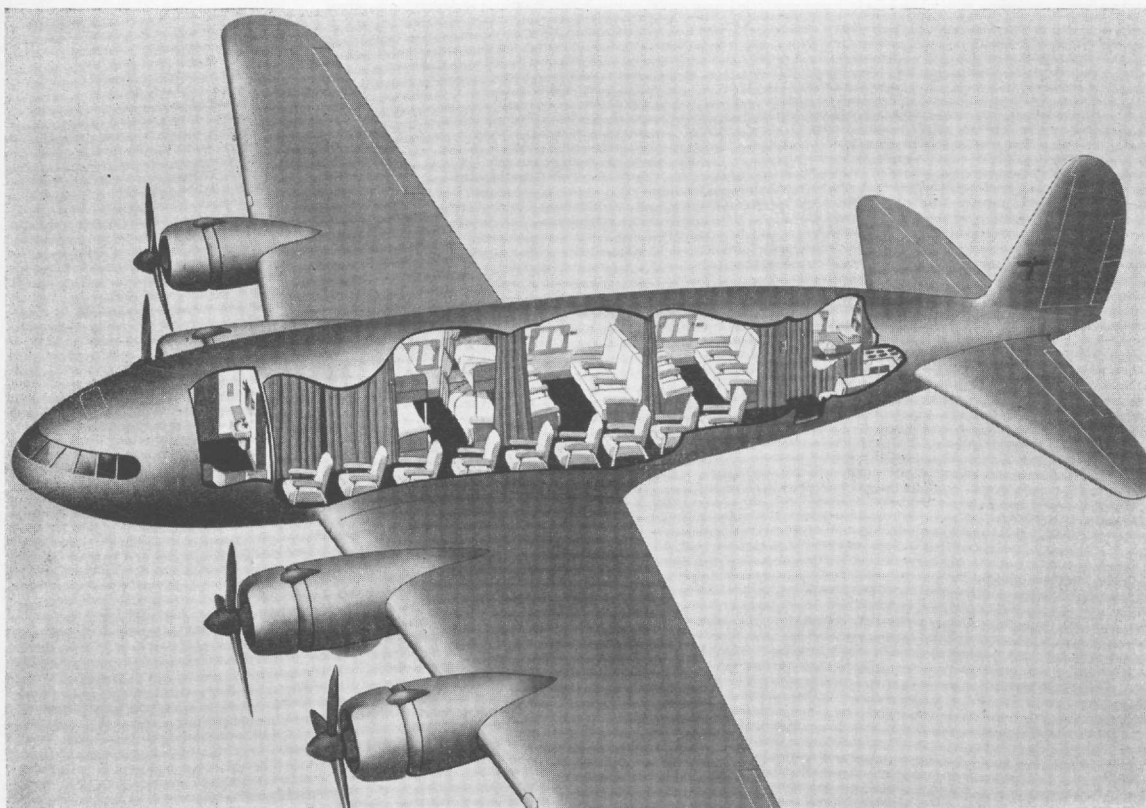
Never before have they been able to capitalize on the inherent advantages of flight in the sub-stratosphere at altitudes of 14,000 to 20,000 feet above sea level. Riding in a moderately supercharged cabin at these heights, passengers will find greater comfort than ever before possible in air travel, and at the same time will be flying far above mountainous areas and disagreeable surface weather conditions. Likewise higher operating speeds may be maintained in the rarefied upper atmosphere.

In a few months, the Boeing Airplane Company of Seattle, Washington will roll out of their factory the first commercial plane built to maintain a consistent transport schedule in the sub-stratosphere. This model 307-S has been appropriately named, the "Stratoliner," because it embodies all the luxuries of a modern liner and yet flies safely in the upper atmosphere.

The Boeing engineers are thoroughly convinced of the reliability of four-engined planes and are now building all their commercial versions with four separate engine units. In incorporating four engines in the new "Stratoliner," they have complete assurance that all the flights will be completed on schedule. With any two of these engines, the ship can maintain flight and climb 200 feet per minute. Complete loss of power in the take-off is no longer a cause of concern. The plane can climb 1,250 feet per minute with all four engines.

A development from the internationally-famous "Flying Fortress" bomber which they built for the Army Air Corps, this new giant of the airlines promises not only to be the fastest but also the most luxurious craft ever to dominate the sky's great highway.

Seated in big, deeply-cushioned chairs, in an air-conditioned cabin, insulated to an exceptionally low sound level, the Stratoliner's thirty-three passengers will travel



A glimpse into the Stratoliner's sealed cabin

in clubroom comfort. Four spacious compartments, located on the right side of the fuselage, with curtains that may be drawn for privacy, are provided for through passengers. Nine individual reclining chairs opposite the compartments are ideal for short-trip passengers. The Stratoliner's furniture, built for complete relaxation, introduces a new pillowy cushioning in place of the customary springs and padding which tend to produce fatigue.

At night the seats in the drawing room compartments may be folded into two soft, roomy and rest-inviting berths designed to assure sound sleeping. They are 6 feet 7 inches long, and in either upper or lower compartments, the tallest ticket purchaser can sit erect with headroom to spare. The transverse arrangement provides level beds both on the ground and in flight. Windows, fresh air inlets, reading lights and call buttons are conveniently placed in both upper and lower berths.

A great deal of artistic skill and clever arranging has been utilized in the small space provided for the women's and men's lavatory. A masterpiece in convenient arrangement, the commodious and tastefully-furnished ladies' dressing room has full-view lighted mirrors, two smartly-styled dressing tables, upholstered seats, wash basin with hot and cold water, built-in towel shelves, ash trays and handy waste containers. Here the lady will be able to dress in a leisurely manner without delaying other passengers. Adjoining the

room is a separate toilet compartment.

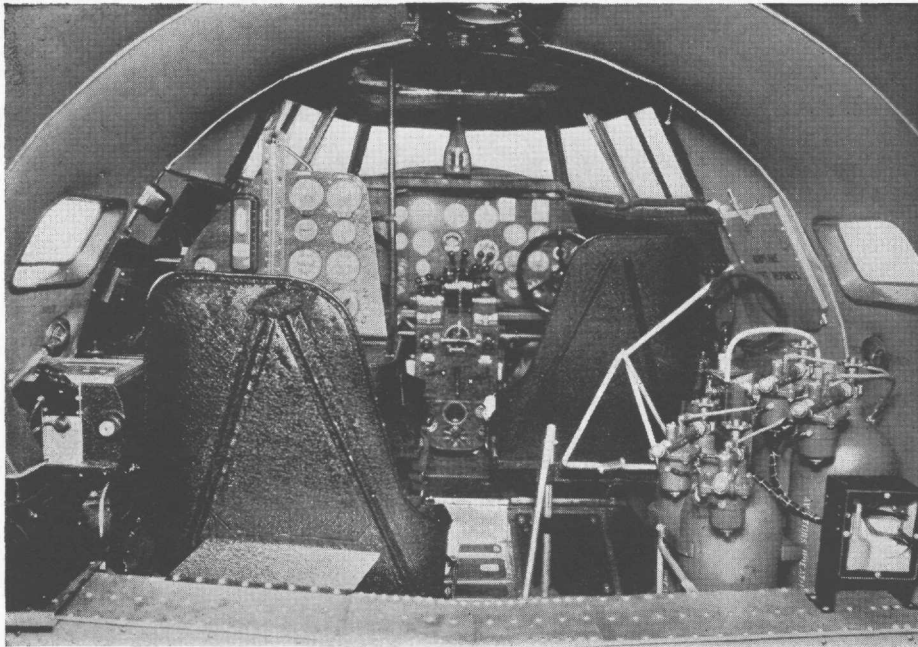
The morning wash-up and shave will be a pleasant chore for the men in their dressing room. It is fitted with two large mirrors, modernistic Lumarith tube lights which provide diffused illumination, two wash basins with hot and cold water, electric razor outlet, towel racks, waste containers, ash trays, and a convenient corner seat. A ceiling height of seven feet has permitted Boeing designers to place fixtures at customary home levels. An adjoining compartment provides toilet facilities.

The ship is also equipped with a modern galley with plenty of "elbow room" and complete facilities for serving hot meals and refreshments to thirty-three passengers, which is admirably suited for efficient aerial stewardship.

The exceptionally-convenient kitchen contains a built-in hot table, rows of thermos containers, plate and cup racks, linen closet and silverware drawers, all ideally arranged for rapid service.

Large serving tables enable the steward to prepare several meal trays at once. Ample cupboard space permits the storage of a wide variety of foods for tasty full-course sky dinners.

Two heavy air-sealed entrances are provided. One leading into the main compartment and used only by the passengers and stewards; the other is a direct entrance through the bottom of the ship to the pilot's



Extreme forward
portion of fuselage

cockpit, making it unnecessary for the crew and airport personnel to pass through the sleeper cabin.

The glass in the large windows on each side of the cabin is made of a special alloy that prevents dangerous ultra-violet rays which are strong because of the lack of ozone at high altitudes. They cause extreme sunburn.

The crew consists of a pilot, co-pilot, radio and ground communications officer, who are housed in the extreme forward portion of the teardrop fuselage, and a steward and stewardess to serve the passengers. The teardrop contour of the fuselage is not broken up by the usual sharp windshield slant because the cockpit is so far forward that the windows can follow the smooth curved nose and still afford good vision.

A large and convenient cargo space is provided in the complete lower deck of the fuselage. Almost two tons of cargo can be carried in this compartment which is also air-conditioned like the cabin.

The control room, designed by pilots to meet the exacting demands of blind flight and instrument landings, has been termed by air line operators "the most efficient and practical transport cockpit ever built." Its size, equipment and mechanical arrangement are the result of careful planning to minimize pilot fatigue.

Many new ingenious mechanical features are being installed in the "Stratoliner." With a wing span of 107 feet, 3 inches and a fuselage length of 74 feet, 4 inches, the total weight will be near 21 tons. The engines are supported in semi-monocoque nacelles with quick detachable engine mounts. Exhaust tail stack, fuel and oil lines, engine controls and instrument drives all disconnect at one readily accessible station. Oil coolers and automatic oil temperature regulators are attached to engine mounts and form part of the power

plant assembly. All engine mounts and power plants are interchangeable within each airplane and may be installed on any nacelle of any other Stratoliner. Thus fewer spare units are required to keep the airplane properly serviced.

All accessories such as batteries, compressors, etc., are installed in the bottom of the fuselage and are readily accessible during flight as well as from the outside. The instruments of the flight panels are interchangeable so they can be changed in a minimum of time.

Four fuel tanks with a total capacity of 1275 gallons are installed in the inner wing sections. Provision has been made for dumping any desired amount of fuel from the main tanks, and no fuel lines are installed within the body of the airplane.

The characteristic Boeing construction has been used in every detail of the Stratoliner's all-metal structure. The fuselage, circular in cross-section throughout its entire length, is of semi-monocoque construction with an aluminum alloy skin covering. Wings are of the typical Boeing combination truss and stressed-skin type. They are also covered with an aluminum alloy. Normal tab controls and aerodynamically balanced ailerons are used on the control surfaces, and the design of flight controls is such that ice formations will not adhere to any portion of the control surface. This will minimize the efforts on the pilot's part.

The balanced-type wing flaps appreciably reduce the landing speed to 70 miles an hour and provide effective airbrakes. The undercarriage, which retracts into the in-board engine nacelles, is of unusually rugged construction. Its shock-absorbing unit, designed for minimum rebound, consists of a large single-leg oleo with ten-inch travel. Landing and tail gear retracting mechanisms and wing flaps are operated by individual direct-

connected electric drives, which insure positive control of the units through all positions. The hydraulic brakes are powerful enough to stop landing wheel rotation under all conditions and are operated by rudder pedal controls.

Power and plenty of it is supplied by four 1,100-horsepower-per-unit Wright "Cyclone" radial motors. A total of 4,400 horsepower is available, which is considerably more than is found in a modern locomotive. Special exhaust collector rings act as a muffler to cut down the deafening roar of these engines.

With but two and one-half pounds per square inch differential between outside and inside pressure, at an actual altitude of 14,700 feet the apparent cabin altitude is only 8,000 feet. The entire fuselage is constructed as an airtight cylinder capable of withstanding an internal pressure of at least 6 pounds per square inch.

Fresh air, drawn through the leading edge of each wing, is compressed by two engine-driven superchargers and circulated throughout the cabin. Spent air is discharged through an exhaust chamber in the accessory compartment below deck. Heating is accomplished by passing the air supply through freeze-proof condenser type steam radiators. Two fully-independent supercharging and heating installations, automatically controlled, assure proper cabin pressure regulation and constant temperature at all times. Additional controls al-

low manual regulation whenever desired.

Supercharged blowers furnish an automatically-controlled fresh air supply of 400 cubic feet per minute, sufficient for 40 persons. Constant ventilation is always maintained, and outside attachments make it possible to circulate conditioned air from ground units while the plane is loading.

Many of the leading airlines have switched all their interests to this new type of transportation, and orders have already been placed for the planes that are being constructed.

Alternative arrangements both for commercial and private executive use are now available in this type craft. For private use, large interior dimensions make possible remarkably complete and luxurious accommodations for sky-tour parties. A distinctively furnished living room with corner davenports, lounging chairs, buffet, radio for program reception, indirect lighting, and Venetian blinds can be obtained. A masters suite with curtained-off bedroom adjoining, kitchenette, guest rooms with sleeping accommodations, dressing rooms and shower bath are among the lavish furnishings ready for any private investor.

So we see that man has finally penetrated this huge stratosphere "sea," of calmness and danger with an ingenious craft of speed, luxury, and comfort, and has thus made it a practical highway for transportation.